TITLE OF THE INVENTION

IMAGE SENSING APPARATUS, INFORMATION PROCESSING
APPARATUS AND METHOD OF CONTROLLING IMAGE SENSING
APPARATUS

FIELD OF THE INVENTION

The present invention relates to an image sensing
apparatus for inputting an image to a personal computer,
an information processing apparatus and a method of
controlling the image sensing apparatus. More
particularly, the present invention relates to an image
sensing apparatus in an image sensing system that uses
an interface the communication speed of which can be
changed over, capable of optimally controlling a variety
of processing within the image sensing apparatus in
accordance with each communication speed, and to an
information processing apparatus and a method of
controlling the image sensing apparatus.

BACKGROUND OF THE INVENTION

A facsimile machine that selects the optimum
transmission speed in conformity with the transmission
quality of a communication line has been proposed, as

disclosed in the specification of Japanese Patent
Application Laid-Open No. 5-252370.

Also available is an image scanner that uses an
interface compliant with RS 232C, IEEE 1284 (parallel),
5   SCSI or USB 1.1, or a special-purpose interface, in
order to be connected to a personal computer.

A bottleneck encountered in terms of image reading
speed in these conventional image sensing apparatus is
the speed of the interface. In an image sensing
10   apparatus that uses an interface having a comparatively
low speed, however, high-quality, efficient transmission
is carried out by converting image data to eight bits
and transmitting the 8-bit data after image processing
such as a shading correction, gamma correction and
15   resolution conversion is executed by hardware.

High-speed serial interfaces such as those
compliant with USB 2.0 and IEEE 1394 have been
standardized in recent years, thereby making possible an
environment in which high-speed transmission can be
20   achieved.

Further, proposal for widening a variable
magnification range by changing speed reduction ratio
using an electromagnetic switch in accordance with a
scanning resolution is disclosed in Japanese Patent
25   Application Laid-Open No. 5-300333.

Furthermore, an apparatus that improves driving
efficiency by transmitting driving power of driving

means to operation means by using different transmission gear ratios for forward scan and backward scan changed by a single direction clutch as well as reduces generation of vibration at the time of image scanning is

5   suggested in Japanese Patent Application Laid-Open No. 2000-013574.

Further, as an image reading apparatus connected to an external apparatus such as a computer or the like when it is used, an image reading apparatus, which

10   operates using electric power supplied from a power supply of the external apparatus via a connection cable such as a USB cable or the like, or using electric power supplied from an AC power supply, is known.

However, when the speed of a processing circuit is

15   raised in order to raise reading speed and exploit a high-speed interface effectively, the cost of such circuitry as an image processing circuit and memory rises and there is also an increase in power consumption and unnecessary radiation.

20   On the other hand, in a processing circuit adapted to operate with a low-speed interface, the high-speed nature of an interface does not manifest itself sufficiently. For example, if a 2-MB buffer memory is constituted by a DRAM, the fact that the DRAM used

25   customarily has a cycle time of 100 ns at the time of random access means that memory access will represent a bottleneck with regard to reading speed when image

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processing that makes repeated reference to the memory
is executed.

Further, minimizing image processing that refers to
a memory, such as processing for a shading correction or
5   gamma correction, to thereby reduce the number of times
memory is accessed also is effective in outputting image
data at high speed. For example, if an analog/digital
converter is a 14-bit converter, one available method is
to transmit 14-bit raw data to a host computer as is and
10   execute all image processing such as a shading
correction using the memory and arithmetic and logical
circuitry of the host computer.

In the case of an image sensing apparatus thus
constructed, the amount of data is nearly doubled
15   because 14 bits are transmitted. However, merely a
high-speed, small buffer memory will suffice because the
transmission speed of image data is sufficiently high in
comparison with the speed at which image data is
generated. However, in a case where a hardware
20   implementation is thus adopted in conformity with the
high-speed transmission mode, 14-bit data is transmitted
in order to avoid a decline in image quality at such
times that it is necessary to use a low-speed
transmission mode because of the configuration of the
25   image sensing system. When it is thus attempted to
transmit 14-bit data, the total amount of data not only
nearly doubles in comparison with the transmission of 8-

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bit data after image processing but the speed of data
generation also increases in comparison with the data
transmission speed. As a consequence, the buffer memory
soon is filled to capacity, the reading of the image

5   data must be suspended and resumed repeatedly and it is
likely that reading speed will diminish to a great
degree.

    Further, a transmission gear mechanism has not been
controlled in accordance with the communication speeds

10   of interfaces conventionally, and thus the apparatus can
not sufficiently cope with a wide communication speed
range. This may result in a large vibration when
operating at low speed and large energy consumption when
operating at high speed.

15   Further, in an image reading apparatus utilized by
connecting to an external apparatus such as a computer,
when such image reading apparatus operates using
electric power supplied from a power supply of an
external apparatus, it may fail to operate normally due

20   to insufficient electric power. This problem readily
occurs when the external apparatus is driven using a
battery.

SUMMARY OF THE INVENTION

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    The present invention has been made in
consideration of the above-mentioned circumstances and

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has as its object to realize optimum reading speed for a wide range of communication speed by a simple and inexpensive circuit arrangement.

It is another object of the present invention to appropriately control power consumption in correspondence with communication speed of an interface.

According to the present invention, the foregoing object is attained by providing an image sensing apparatus capable of connecting to an external information processing apparatus, comprising: an image sensor adapted to sense an object and output an image signal representing the image of the object; a signal processor adapted to subject the image signal to predetermined signal processing; a communication unit adapted to communicate with the information processing apparatus; and a controller adapted to change over a control method of the signal processor in accordance with the communication speed of the communication unit.

Further, foregoing object is also attained by providing an information processing apparatus capable of controlling an external image sensing apparatus by connecting thereto, the external image sensing apparatus having an image sensor adapted to sense an object and output an image signal representing the image of the object, a signal processor adapted to subject the image signal to predetermined signal processing, and a communication unit adapted to perform communication, the

information processing apparatus comprising: a
communication unit adapted to communicate with the
external image sensing apparatus; a sensor adapted to
sense communication speed of the communication unit; a

5   signal processor adapted to subject the image signal,
which has been obtained from the image sensing
apparatus, to predetermined signal processing; and a
controller adapted to perform control so as to change
over a method of controlling the signal processor of the

10 external image sensing apparatus in accordance with the
communication speed sensed by the sensor, and change
over control of the signal processor within the
information processing apparatus.

Furthermore, the foregoing object is also attained

15 by a method of controlling an image sensing apparatus
having an image sensor adapted to sense an object and
output an image signal representing the image of the
object, a signal processor adapted to subject the image
signal to predetermined signal processing, and a

20 communication unit adapted to perform communication, the
method comprising; a sensing step of sensing
communication speed of the communication unit; and a
control step of performing control so as to change over
a method of controlling the signal processor in

25 accordance with the communication speed sensed at the
sensing step.

Other features and advantages of the present
invention will be apparent from the following
description taken in conjunction with the accompanying
drawings, in which like reference characters designate
5   the same or similar parts throughout the figures
thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

10   The accompanying drawings, which are incorporated
in and constitute a part of the specification,
illustrate embodiments of the invention and, together
with the description, serve to explain the principles of
the invention.

15   Fig. 1 is a schematic view illustrating the
external appearance of an image reading system according
to a first embodiment of the present invention;

Fig. 2 is a block diagram illustrating the system
configuration of software according to the first
20   embodiment;

Fig. 3 is a flowchart illustrating the operating
sequence of an image reading apparatus when an
application is launched according to the first
embodiment of the present invention;

25   Fig. 4 is a flowchart illustrating the operating
sequence of a host computer when an application is

launched according to the first embodiment of the
present invention;

Fig. 5 is a diagram illustrating an example of an
operating screen according to the first embodiment;

Fig. 6 is a block diagram illustrating the
structure of an image reading apparatus according to the
first embodiment;

Fig. 7 is a flowchart illustrating reading control
by the host computer according to the first embodiment;

Fig. 8 is a flowchart illustrating reading control
by the host computer according to the first embodiment;

Fig. 9 is a block diagram illustrating the
structure of an image reading apparatus according to a
second embodiment of the present invention;

Fig. 10 is a flowchart illustrating reading control
by a host computer according to the second embodiment;

Fig. 11 is a flowchart illustrating reading control
by a host computer according to the second embodiment;

Fig. 12 is a block diagram illustrating the
structure of an image reading apparatus according to a
third embodiment of the present invention;

Fig. 13 is a block diagram illustrating the
structure of an image reading apparatus according to a
fourth embodiment of the present invention;

Fig. 14 is a flowchart illustrating reading control
by a host computer according to the fourth embodiment;

Fig. 15 is a flowchart illustrating reading control by a host computer according to the fourth embodiment;

Fig. 16 is a sectional view showing the mechanical arrangement of an image reading apparatus according to a sixth embodiment of the present invention;

Fig. 17 is a block diagram showing the circuit arrangement of the image reading apparatus according to the sixth embodiment of the present invention;

Fig. 18 is a flowchart showing the operation upon setting an operation mode in the image reading apparatus according to the sixth embodiment of the present invention;

Fig. 19 is a view showing the mechanical arrangement of an image reading apparatus according to a seventh embodiment of the present invention;

Fig. 20 is a block diagram showing the circuit arrangement of an image reading apparatus according to an eighth embodiment of the present invention;

Fig. 21 is a flowchart showing the operation of the image reading apparatus according to the eighth embodiment of the present invention;

Fig. 22 is a flowchart showing the operation of the image reading apparatus according to the eighth embodiment of the present invention;

Fig. 23 is a flowchart showing the operation of the image reading apparatus according to the eighth embodiment of the present invention;

Fig. 24 is a flowchart showing the operation of the image reading apparatus according to the eighth embodiment of the present invention; and

Fig. 25 is a view showing the mechanical arrangement of the image reading apparatus according to the eighth embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Preferred embodiments of the present invention will be described in detail in accordance with the accompanying drawings. In the embodiments of the invention, an image reading apparatus such as a scanner will be described as an example of an image sensing apparatus. However, the invention is applicable to all image sensing apparatus, such as video cameras and digital still cameras, in which image data can be transmitted to an external information processing apparatus in real time.

<First Embodiment>

Fig. 1 is a schematic view illustrating the external appearance of an image reading system according to a first embodiment of the present invention, and Fig. 2 is a block diagram illustrating the system configuration of software of the image reading system in the first embodiment.

As shown in Fig. 1, the system includes an image

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reading apparatus 1 having a platen glass 2 for holding
a document 3, a pressure applying cover 5 and a start
key 7 for launching an application and commanding the
start of reading. The system further includes a USB
5   interface cable 8 and a host computer 20 having an
operating window 21 for the application software.

     As shown in Fig. 2, the image reading apparatus 1
further has a light source 6, a scanner controller 9 for
controlling the image reading apparatus 1, and a USB
10   interface 10. The host computer 20 includes a USB
interface 22, a system driver 23 for controlling various
resources in the host computer 20, a device driver 24
for controlling the image reading apparatus 1 in the
host computer 20, a control panel 25 for a management
15   program that manages the operating environment, such as
the launching and quitting of application software, in
the host computer, a tool box 26 of a control program
that controls application software for driving the image
reading apparatus 1, and a scan controller 27 of an
20   application program for performing an operation relating
to image reading by the image reading apparatus 1.

     When the USB interface cable 8 is connected in Fig.
2, enumeration is performed between the image reading
apparatus 1 and the host computer 20 and the
25   communication speed of the interface is decided. The
USB interface 10 on the side of the image reading
apparatus 1 subsequently operates at the communication

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speed decided at this time. The USB interface 22 on the
side of the host computer 20 also operates at the
communication speed decided at this time.

  The sequence of operations performed by the image
5 reading apparatus 1 when an application is launched in
the first embodiment of the present invention will now
be described with reference to Fig. 3.

  Fig. 3 is a flowchart illustrating a sequence in a
case where operation of the start key 7 is processed by
10 polling to report this operation to the host computer
20. The scanner controller 9 checks the operating
status of the start key 7 periodically. Processing of
operation of the start key 7 may be performed by polling
from the scan controller 27.

15 If processing starts, the image reading apparatus 1
checks whether the start key 7 has been pressed at step
S1. If the key 7 has been pressed, control proceeds to
step S2, where the fact that the key has been pressed is
reported to the host computer 20. Control then proceeds
20 to step S3. If the key 7 has not been pressed, on the
other hand, then control proceeds directly from step S1
to step S3. Here the image reading apparatus waits for
a fixed period of time (e.g., 10 ms) using a timer,
after which control returns to step S1.

25 With regard to the determination as to whether the
start key 7 has been pressed at step S1, it is
determined that the key has been pressed when the key is

held depressed for a fixed period of time following non-depression of the key for a fixed period of time.
Conversely, it can be determined that the key has been pressed when the key remains in a non-depressed state

5   for a fixed period of time following continuous depression of the key for a fixed period of time.

       Fig. 3 illustrates a method in which notification of operation of the start key 7 is performed by polling. It is also permissible to adopt a method in which

10   depression of the start key 7 is processed by applying a hardware interrupt. In such case the fact that the start key 7 has been pressed is conveyed to the scanner controller 9 by an interrupt signal, and the scanner controller 9 sends information indicating that the start

15   key has been pressed to the host computer 20 via the USB interface 10 by interrupt transfer.

       Fig. 4 is a flowchart useful in describing the operating sequence of the host computer 20 when an application is launched in the first embodiment of the

20   invention. Specifically, Fig. 4 illustrates the sequence of processing by the tool box 26 of a control program that controls the application software of the image reading apparatus 1 in the host computer 20.

       When information indicating that the start key 7

25   has been pressed is transmitted from the image reading apparatus 1 by the processing of Fig. 3, the host computer 20 receives this information by its USB

interface 22 via the USB interface cable 8. When the
system driver 23 receives the information indicative of
depression of the start key from the USB interface 22,
this fact is reported to the device driver 24. The
5   latter notifies the control panel 25 to start up the
tool box 26.

When the tool box 26 is started up by the control
panel 25, the host computer 20 recognizes the fact that
the start key 7 of the image reading apparatus 1 has
10 been pressed. The host computer 20 determines at step
S11 whether the scan controller 27 has started
operating. If the scan controller 27 has started
operating, processing corresponding to other start-up
factors is executed at step S12. If the scan controller
15 27 has not started up, control proceeds to step S13.
Here the scan controller 27 is started up.

Fig. 5 is a diagram useful in describing the
operating screen of the scan controller 27. This screen
is presented on the screen of the host computer 20 when
20 an image is read from a document.

As shown in Fig. 5, an operating window 21 is
displayed on the screen of the host computer 20. This
operating window is displaying a preview image presented
following pre-scanning.

25   The screen includes a display window 32, a cursor
33 for designating the reading range of a document, a
preview screen 34, a preview key 35 for designating

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start of pre-scanning and obtaining a preview image, a
mode setting button 36 for setting a scanning mode such
as the gamma characteristic (density-characteristic
curve), a main scan start button 37, a resolution
setting bar 38 and a color balance setting bar 39.
Settings are made and scanning is started by clicking
the buttons and dragging the bars using a mouse (not
shown) or the like.

Fig. 6 is a block diagram illustrating the
structure of the image reading apparatus 1 according to
the first embodiment of the present invention. As shown
in Fig. 6, the apparatus 1 includes the platen glass 2
on which the document 3 is placed and the USB interface
10 connected to the host computer 20 by the USB
interface cable 8. The host computer 20 executes the
control program of the scanner. The image reading
apparatus 1 further includes a contact sensor 65 driven
in the sub-scanning direction, a carriage drive
mechanism 67 for performing scanning in the sub-scanning
direction by driving the contact sensor 65 in the sub-
scanning direction, a stepping motor 68 for moving the
contact sensor 65 in the sub-scanning scanning direction
via the carriage drive mechanism 67, a timing generator
71 for generating timing clock signals necessary for the
contact sensor 65, an image processing circuit, and the
like, a sequence control circuit 72 for performing a
series of sequence control operations, such as motor

control and control for turning lamps on and off in
accordance with values that have been set from the host
computer 20 via the USB interface 10, an LED control
circuit 73 for controlling the lighting of LEDs, an LED
5   74 for illuminating the document, a light guide 75 for
illuminating the document, imaging optics (SLA) 76 for
introducing the image of the document, which has been
placed on the platen glass 2, onto an image sensing
element 77 that is for reading the image, an analog
10   circuit 78 (referred to generally as an analog front end
(AFE)) that includes an A/D converter for converting the
output analog signal of the image sensing element 77 to
a digital signal, an image processing circuit 79 for
executing a shading correction, a gamma correction and
15   scaling processing, etc., and a buffer memory 80 used
for image processing and to transfer image data.

The contact sensor 65 carries the LED 74 for
illuminating the document, the light guide 75, the
imaging optics 76 and the image sensing element 77. The
20   sequence control circuit 72 controls the stepping motor
68 in accordance with values set from the host computer
20 via the USB interface 10 and moves the contact sensor
65 in the sub-scanning scanning direction via the
carriage drive mechanism 67. The set values are the
25   pulse rate and rotating direction, etc., of the stepping
motor 68.

Control of the image reading apparatus 1 having the

structure set forth above will now be described.

Figs. 7 and 8 are flowcharts illustrating the control program in a case where control of reading by the image reading apparatus 1 is performed by the host computer 20 in accordance with the first embodiment.

The driver control sequence will be described with reference to Figs. 7 and 8.

First, if the USB interface cable 8 is connected or power is introduced to the host computer 20, enumeration is carried out at step S21 to recognize the device connected to the interface, assign addresses and decide the communication speed. The method of deciding the communication speed of the USB interface has been standardized. Since an image input apparatus of the present invention is assumed to support USB 2.0, if the host computer supports USB 2.0, the communication speed, therefore, is placed in the high-speed (fast) mode (480 Mbps). On the other hand, in a case where the host computer supports USB 1.1 but not support USB 2.0, the communication speed is decided on as being full-speed (slow) mode (12 Mbps). Here it is assumed that the image reading apparatus 1 has been connected. Further, if the image reading apparatus and the host computer support IEEE 1394 and other devices have been connected between the host computer and the image reading apparatus, then the communication speed is set to the speed of the device whose communication speed is lowest.

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For example, assume that the communication speed of an IEEE-1394 interface of the host computer is 400 MHz. If the host computer has been connected to a mass storage device whose communication speed is 200 MHz and the mass storage device has been connected to a 400-MHz image reading apparatus, the communication speed of the image reading apparatus is determined to be 200 MHz.

Next, when the device driver 24 for the image reading apparatus 1 is started up in the host computer 20, the device driver 24 discriminates whether the communication speed is that of a fast mode or that of a slow mode at step S22. Specifically, the device driver 24 makes this determination by obtaining information relating to the communication mode (communication speed) of the applicable communication channel from the system driver 23 after the communication speed is decided. After the communication speed has been determined, the device driver 24 of the host computer 20 changes over the set values of the image processing circuit 79 or control of the sequence control circuit 72 in accordance with the communication speed. Control proceeds to step S23 when the communication speed is that of the fast mode and to step S41 (Fig. 8) when the communication speed is that of the slow mode.

When the communication speed is that of the fast mode, each of the processing circuits of the image reading apparatus 1 is initialized with respect to the

fast mode (step S23). For example, a setting is made to
bypass the shading correction, gamma correction and
scaling by the image processing circuit 79, and a
setting is made in such a manner that 14-bit data output
5   from the analog front end will be output to a data-
transmission FIFO 11 incorporated in the USB interface
10. The effective speed of communication between the
image reading apparatus 1 and the host computer 20 in
the fast mode is measured at step S24.

10   Next, at step S25, a clock of the timing generator
71 is set based upon the effective speed of
communication. The contact sensor 65 is returned to the
home position, after which calibration is performed
(step S26).

15   This is followed by step S27, at which the host
computer 20 obtains white shading data and black shading
data and obtains correction data by calculation.

Next, at step S28, it is determined whether the
preview key 35 of the operating window 21 has been
20   pressed. Control proceeds to step S30 if the preview
key 35 has been pressed and to step S29 if it has not.

The image is read coarsely (i.e., at a low
resolution) at step S30 in order to obtain a preview
image, and raw data representing the image. i.e., 14-bit
25   data that is output from the analog front end, is
transmitted to the host computer 20 as is. The device
driver 24 subjects the transmitted preview image data to

predetermined image processing such as a shading correction at step S31 and displays the image data thus processed on the preview screen 34 at step S32. Control then returns to step S28.

5   It is determined at step S29 whether the main scan start button 37 on the operating window 21 has been pressed. Control proceeds to step S33 if the main scan start button 37 has been pressed and returns to step S28 if it has not.

10   The image is read by main scanning at step S33 and the raw data representing the image is transmitted to the host computer 20. The device driver 24 subjects the transmitted image data to predetermined processing such as a shading correction at step S34 and stores the

15   processed image data in a file at step S35. Control then returns to step S28.

When it is judged that the communication speed is that of the slow mode ("NO" at step S22), control proceeds to step S41 in Fig. 8. Here each of the

20   processing circuits of the image reading apparatus 1 is initialized with respect to the slow mode. For example, a setting is made so that the shading correction, gamma correction and scaling are performed by the image processing circuit 79, and a setting is made in such a

25   manner that 8-bit data that is output from the image processing circuit 79 will be output to the data-transmission FIFO 11 incorporated in the USB interface

10. The effective speed of communication between the image reading apparatus 1 and the host computer 20 in the slow mode is measured at step S42.

Next, at step S43, a clock of the timing generator 71 is set based upon the effective speed of communication. The contact sensor 65 is returned to the home position, after which calibration is performed (step S44).

This is followed by step S45, at which the host computer obtains white shading data and black shading data and obtains correction data by calculation.

Next, at step S46, it is determined whether the preview key 35 of the operating window 21 has been pressed. Control proceeds to step S48 if the preview key 35 has been pressed and to step S47 if it has not.

Calibration data corresponding to the resolution of the preview image is obtained and the setting of shading correction data, gamma correction data and scaling factor is performed at step S48. This is followed by step S49, at which the image is read, the read image data is subjected to predetermined image processing such as a correction by the image processing circuit 79 and the processed image data is transmitted to the host computer 20. The host computer 20 displays the received image data on the preview screen at step S50. Control then returns to step S46.

It is determined at step S47 whether the main scan

start button 37 on the operating window 21 has been pressed. Control proceeds to step S51 if the main scan start button 37 has been pressed and returns to step S46 if it has not.

5   Calibration data corresponding to the resolution of main scanning is obtained and the setting of shading correction data, gamma correction data and scaling factor is performed at step S51. This is followed by step S52, at which the image is read, the read image

10   data is subjected to predetermined image processing such as a correction by the image processing circuit 79 and the processed image data is transmitted to the host computer 20. The host computer 20 stores the received image data in a file at step S53. Control then returns

15   to step S46.

Thus, in accordance with the first embodiment as described above, the method of controlling the processing circuits, e.g., the method of image processing performed by the image processing circuit 79

20   and the method of controlling scanning of the sequence control circuit 72, are changed in accordance with the speed of communication between the image reading apparatus 1 and the host computer 20. As a result, the optimum reading speed can be realized in both the slow

25   mode and fast mode by a simple and inexpensive circuit arrangement.

<Second Embodiment>

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Next, the second embodiment of the present invention will be described.

An image reading apparatus according to the second embodiment is shown in Fig. 9. As shown in Fig. 9, a communication speed selection switch 50 for switching the communication speed of the interface 10 and a gear mechanism 60 for changing the moving speed of the contact sensor 65 are added to the configuration shown in Fig. 6. The other configuration are the same as those described in the first embodiment, and thus referred to by the same reference numerals and explanation of them are omitted.

Figs. 10 and 11 are flowcharts illustrating the control in a case where control of reading by the image reading apparatus 1 is performed by the host computer 20 in the image reading system having the aforesaid configuration. It should be noted that the same processes as those shown in Figs. 7 and 8 of the first embodiment are referred to by the same step numbers, and explanation of those processes will be partially omitted.

First, if the USB interface cable 8 is connected or power is introduced to the host computer 20, enumeration is carried out at step S21 to recognize the device connected to the interface, assign addresses and decide the communication speed. In the second embodiment, the communication speed of the image reading apparatus 1 can

be decided by the communication speed selection switch
50. If the communication speed selection switch 50
selects the high-speed mode, then the interface 10
notifies the host compute 20 that the image reading
5   apparatus 1 operates in the high-speed mode at the time
of enumeration. If the communication speed selection
switch 50 does not select the high-speed mode, then the
interface 10 notifies the host computer 20 that the
image reading apparatus 1 does not operate in the high-
10   speed mode at the time of enumeration.

Next, when the device driver 24 for the image
reading apparatus 1 is started up in the host computer
20, the device driver 24 discriminates whether the
communication speed is that of a fast (high-speed) mode
15   or that of a slow (full-speed) mode at step S22.

If the communication speed is discriminated as that
of the fast mode, the gear mechanism 60 is changed to a
high-speed side at step S61, and control proceeds to
step S23. Whereas, if the communication speed is
20   discriminated as that of the slow mode, control proceeds
to step S62 in Fig. 11.

At step S23, each of the processing circuits of the
image reading apparatus 1 is initialized with respect to
the fast mode (step S23). For example, a setting is
25   made to bypass the shading correction, gamma correction
and scaling by the image processing circuit 79, and a
setting is made in such a manner that 14-bit data output

from the analog front end 78 will be output to a data-transmission FIFO 11 incorporated in the USB interface 10. The effective speed of communication between the image reading apparatus 1 and the host computer 20 in the fast mode is measured at step S24.

Next, at step S25, a clock of the timing generator 71 is set based upon the effective speed of communication. The contact sensor 65 is returned to the home position, after which calibration is performed (step S26).

This is followed by step S27, at which the host computer 20 obtains white shading data and black shading data and obtains correction data by calculation.

Next, at step S28, it is determined whether the preview key 35 of the operating window 21 has been pressed. Control proceeds to step S30 if the preview key 35 has been pressed and to step S29 if it has not.

The image is read coarsely (i.e., at a low resolution) at step S30 in order to obtain a preview image, and raw data representing the image. i.e., 14-bit data that is output from the analog front end 78, is transmitted to the host computer 20 as is, and the contact sensor 65 is returned to the home position. The device driver 24 subjects the transmitted preview image data to predetermined image processing such as a shading correction at step S31 and displays the image data thus processed on the preview screen 34 at step S32. Control

then returns to step S28.

It is determined at step S29 whether the main scan
start button 37 on the operating window 21 has been
pressed. Control proceeds to step S33 if the main scan
start button 37 has been pressed and returns to step S28
if it has not.

The image is read by main scanning at step S33 and
the raw data representing the image is transmitted to
the host computer 20, and the contact sensor 65 is
returned to the home position. The device driver 24
subjects the transmitted image data to predetermined
processing such as a shading correction at step S34 and
stores the processed image data in a file at step S35.
Control then returns to step S28.

When it is judged that the communication speed is
that of the slow mode ("NO" at step S22), control
proceeds to step S62 in Fig. 11. At step S62, the gear
mechanism 60 is changed to a slow-speed side. This is
followed by step S41 where each of the processing
circuits of the image reading apparatus 1 is initialized
with respect to the slow mode. For example, a setting
is made so that the shading correction, gamma correction
and scaling are performed by the image processing
circuit 79, and a setting is made in such a manner that
8-bit data that is output from the image processing
circuit 79 will be output to the data-transmission FIFO
11 incorporated in the USB interface 10. The effective

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speed of communication between the image reading
apparatus 1 and the host computer 20 in the slow mode is
measured at step S42.

Next, at step S43, a clock of the timing generator
71 is set based upon the effective speed of
communication. The contact sensor 65 is returned to the
home position, after which calibration is performed
(step S44).

This is followed by step S45, at which the host
computer obtains white shading data and black shading
data and obtains correction data by calculation.

Next, at step S46, it is determined whether the
preview key 35 of the operating window 21 has been
pressed. Control proceeds to step S48 if the preview
key 35 has been pressed and to step S47 if it has not.

Calibration data corresponding to the resolution of
the preview image is obtained and the setting of shading
correction data, gamma correction data and scaling
factor is performed at step S48. This is followed by
step S49, at which the image is read, the read image
data is subjected to predetermined image processing such
as a correction by the image processing circuit 79 and
the processed image data is transmitted to the host
computer 20, and the contact sensor 65 is returned to
the home position. The host computer 20 displays the
received image data on the preview screen at step S50.
Control then returns to step S46.

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It is determined at step S47 whether the main scan start button 37 on the operating window 21 has been pressed. Control proceeds to step S51 if the main scan start button 37 has been pressed and returns to step S46

5   if it has not.

Calibration data corresponding to the resolution of main scanning is obtained and the setting of shading correction data, gamma correction data and scaling factor is performed at step S51. This is followed by

10   step S52, at which the image is read at a speed based on the resolution, the read image data is subjected to predetermined image processing such as a correction by the image processing circuit 79 and the processed image data is transmitted to the host computer 20, and the

15   contact sensor 65 is returned to the home position. The host computer 20 stores the received image data in a file at step S53. Control then returns to step S46.

Thus, in accordance with the second embodiment as described above, whether the communication speed set by

20   the communication speed selection switch 50 is that of the fast (high-speed) mode or the slow (full-speed) mode is determined, and the transmission gear ratios and the method of controlling the driving source included in a driver are changed in accordance with the determined

25   communication speed. As a result, low vibration and the optimum reading speed can be realized in both the slow mode and fast mode by a simple and inexpensive motor.

<Third Embodiment>

Fig. 12 is a block diagram illustrating the structure of an image reading apparatus according to a third embodiment of the present invention. Components in Fig. 12 identical with those shown in Fig. 6 are designated by like reference characters and need not be described again.

It should be noted that the output of the analog front end 78 is assumed to have a bus width of 16 bits. Further, the image reading apparatus 1 of the third embodiment further includes a bus selector 82 for changing over a bus signal with a bus width of 16 bits, and a FIFO memory 83 capable of being accessed at high speed and having a bus width of 16 bits. The FIFO memory 83 is included in the USB interface 10 and is used to adjust timing for transmission of image data.

A bus selection signal SEL, which corresponds to the communication mode, is output to the bus selector 82 from the interface 10. The slow mode is the default mode.

A write-control signal WEN, which indicates the effective image data output to the USB interface 10, is output to the USB interface 10 from the image processing circuit 79.

When the communication speed is high, the image data output from the analog front end 78 bypasses the image processing circuit 79 and enters the high-speed

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FIFO memory 83, which is provided within the USB
interface 10, via the bus selector 82. The write-
control signal WEN indicative of the effective image
data is output from the image processing circuit 79 to
5   the USB interface 10.

When the communication speed is low, the image data
output from the analog front end 78 is subjected to a
shading correction, gamma correction and scaling
processing by the image processing circuit 79, and the
10 processed image data is input to the high-speed FIFO
memory 83 in interface 10 via the bus selector 82.

Effects similar to those of the first embodiment
can be obtained by the arrangement of the third
embodiment.

15   <Fourth Embodiment>

Next, the fourth embodiment of the present
invention will be described.

An image reading apparatus according to the second
embodiment is shown in Fig. 13. As shown in Fig. 13, a
20 gear mechanism 60 is added within the carriage drive
mechanism 67 to the configuration shown in Fig. 12. The
other configuration are the same as those shown in Fig.
12, and thus referred to by the same reference numerals
and explanation of them are omitted. The default mode
25 of the bus selection signal SEL for the bus selector 82
is the fast mode in the fourth embodiment.

Next, a sequence controlled by the host computer 20

according to the fourth embodiment is explained with
reference to Figs. 14 and 15. It should be noted that
the same processes as those shown in Figs. 7 and 8 of
the first embodiment are referred to by the same step

5   numbers, and explanation of those processes will be
partially omitted.

First, if the USB interface cable 8 is connected or
power is introduced to the host computer 20, enumeration
is carried out at step S21 to recognize the device

10 connected to the interface, assign addresses and decide
the communication speed.

Next, when the device driver 24 for the image
reading apparatus 1 is started up in the host computer
20, the gear mechanism 60 is changed to a high-speed

15 side at step S71. Then, the device driver 24
discriminates whether the communication speed is that of
a fast mode or that of a slow mode at step S22. When
the communication speed is that of the fast mode,
control proceeds to step S23, whereas when the

20 communication speed is that of the slow mode, control
proceeds to step S41 in Fig. 15.

At step S23, each of the processing circuits of the
image reading apparatus 1 is initialized with respect to
the fast mode. For example, a setting is made to bypass

25 the shading correction, gamma correction and scaling by
the image processing circuit 79, and a setting is made
in such a manner that 16-bit data output from the analog

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front end 78 will be output to a data-transmission FIFO
83 incorporated in the USB interface 10. Note that the
timing generator 71 is set to generate a fast driving
clock for the image sensing element 77. The effective
5   speed of communication between the image reading
apparatus 1 and the host computer 20 in the fast mode is
measured at step S24.

Next, at step S25, a clock of the timing generator
71 is set based upon the effective speed of
10   communication. The contact sensor 65 is returned to the
home position, after which calibration is performed
(step S26).

This is followed by step S27, at which the host
computer 20 obtains white shading data and black shading
15   data and obtains correction data by calculation.

Next, at step S28, it is determined whether the
preview key 35 of the operating window 21 has been
pressed. Control proceeds to step S30 if the preview
key 35 has been pressed and to step S29 if it has not.

20   The image is read coarsely (i.e., at a low
resolution) at step S30 in order to obtain a preview
image, and raw data representing the image. i.e., 16-bit
data that is output from the analog front end 78, is
transmitted to the host computer 20 as is, and returning
25   of the contact sensor 65 to the home position starts at
step S72. The device driver 24 subjects the transmitted
preview image data to predetermined image processing

such as a shading correction at step S31 and displays
the image data thus processed on the preview screen 34
at step S32. Control then returns to step S28.

It is determined at step S29 whether the main scan
start button 37 on the operating window 21 has been
pressed. Control proceeds to step S33 if the main scan
start button 37 has been pressed and returns to step S28
if it has not.

The image is read by main scanning at step S33 and
the raw data representing the image is transmitted to
the host computer 20, and returning of the contact
sensor 65 to the home position starts at step S73. The
device driver 24 subjects the transmitted image data to
predetermined processing such as a shading correction at
step S34 and stores the processed image data in a file
at step S35. Control then returns to step S28.

When it is judged that the communication speed is
that of the slow mode ("NO" at step S22), control
proceeds to step S41 at which each of the processing
circuits of the image reading apparatus 1 is initialized
with respect to the slow mode. For example, a setting
is made so that the shading correction, gamma correction
and scaling are performed by the image processing
circuit 79, and a setting is made in such a manner that
8-bit data that is output from the image processing
circuit 79 will be output to the data-transmission FIFO
83 incorporated in the USB interface 10. The effective

speed of communication between the image reading
apparatus 1 and the host computer 20 in the slow mode is
measured at step S42.

Next, at step S43, a clock of the timing generator
71 is set based upon the effective speed of
communication. The contact sensor 65 is returned to the
home position, after which calibration is performed
(step S44).

This is followed by step S45, at which the host
computer obtains white shading data and black shading
data and obtains correction data by calculation.

Next, at step S46, it is determined whether the
preview key 35 of the operating window 21 has been
pressed. Control proceeds to step S48 if the preview
key 35 has been pressed and to step S47 if it has not.

Calibration data corresponding to the resolution of
the preview image is obtained and the setting of shading
correction data, gamma correction data and scaling
factor is performed at step S48. This is followed by
step S49, at which the image is read, the read image
data is subjected to predetermined image processing such
as a correction by the image processing circuit 79 and
the processed image data is transmitted to the host
computer 20. At step S74, the contact sensor 65 starts
to return. The host computer 20 displays the received
image data on the preview screen at step S50. Control
then returns to step S46.

It is determined at step S47 whether the main scan start button 37 on the operating window 21 has been pressed. Control proceeds to step S51 if the main scan start button 37 has been pressed and returns to step S46
5 if it has not.

Calibration data corresponding to the resolution of main scanning is obtained and the setting of shading correction data, gamma correction data and scaling factor is performed at step S51. Next, the gear
10 mechanism 60 is changed to a low-speed side at step S75. This is followed by step S52, at which the image is read at a speed based on the resolution, the read image data is subjected to predetermined image processing such as a correction by the image processing circuit 79 and the
15 processed image data is transmitted to the host computer 20. Then at step S76, the gear mechanism 60 is changed to the high-speed side, and returning of the contact sensor 65 to the home position starts at step S77. The host computer 20 stores the received image data in a
20 file at step S53. Control then returns to step S46.

Thus, in accordance with the fourth embodiment as described above, since a high-speed side of a gear mechanism is set as a default mode, the previewing is performed at high speed. More specifically, even when
25 the communication speed is that of the full-speed (slow) mode, the gear mechanism is set to the high-speed side when the previewing is performed. Further, the gear

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mechanism is also set to the high-speed side when
returning a contact sensor to the home position, which
realizes efficient returning operation. Furthermore,
the gear mechanism is set to the slow-speed side only
5   when reading the image by main scanning in the full-
speed mode. Accordingly, an image can be read at high
resolution with high precision with low vibration by
operating at a low speed.

      <Fifth Embodiment>

10   The arrangement of Fig. 6 may be so adopted that
the buffer memory 80 is constructed by an EDO-type DRAM,
wherein the buffer memory is employed exclusively as an
image-data transmission buffer using a page mode when
the communication speed is high, and is employed also
15   for table reference for the purpose of performing the
shading and gamma corrections when the communication
speed is low. With regard to memory access in the page
mode, high-speed access can be made feasible by writing
and reading image data to and from contiguous addresses
20   eight bytes at a time, wherein the image data is
composed of four pixels per color and is written/read in
units of eight bytes, by way of example. This changing
over of the DRAM access mode can be achieved easily by
previously fabricating a circuit that executes the
25   access modes in the image processing circuit 79 and
effecting the changeover by a value set in a register.

    In another example, it can be so arranged that a

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small-capacity memory capable of high-speed access provided in the image processing circuit 79 is used at the time of high-speed communication, and a low-speed high-capacity memory (buffer memory 80) provided

5 externally of the image processing circuit 79 is used at the time of low-speed communication.

In accordance with the fifth embodiment as described above, the memory access method of storage controller is changed over based upon a communication

10 mode decided by communication-mode decision means. As a result, the optimum reading speed can be realized in both the slow mode and fast mode by a simple and inexpensive circuit arrangement.

<Modifications>

15 In the second and fourth embodiments, the gear mechanism 60 may be changed to the low-speed side when the reading resolution is high and the communication speed is slow.

Further, it is described that the gear mechanism 60

20 is changed between the high-speed side and the low-speed side, however, the number of choices is not limited to two, and the gear mechanism 60 may be changed among 3 or more choices. Further, the gear mechanism 60 may be changed in accordance with a communication speed, an

25 image read mode (resolution, color/monochrome/binary), crop width, and/or ability of a host computer.

Further, the interface is not limited to those

compliant with USB, and an interface compliant with IEEE 1394, for instance, may be used. Moreover, when a plurality of interfaces are provided, the gear mechanism 60 may be changed in accordance with the interface for communication.

Further, the image reading apparatuses described in the first to fourth embodiment have configurations which use contact sensors. However, the present invention is not limited to this, and any known image reading mechanism can be adopted.

<Sixth Embodiment>

Next, the sixth embodiment of the present invention will be described.

Fig. 16 is a sectional view showing the mechanical arrangement of an image reading apparatus according to the sixth embodiment of the present invention. A contact image sensor (CIS) 101 for reading a document image has a photodiode 102, SELFOC lens 103, LED array 104, and contact glass 105. Feed rollers 106 for feeding a document are disposed before and after the CIS 101, and feed a document below the contact glass 105. A contact sheet 107 makes the document contact the lower surface of the contact glass 105. Such system for reading the document image while feeding the document is called a sheet-feed type.

When a document is inserted into a document insert port, a document detect lever 108 tilts, and the output

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from a document sensor 109 changes in accordance with
this tilt.   A CPU 215 (to be described later; see Fig.
17) can detect insertion of the document on the basis of
the change in output from the document sensor 109.   Upon
5   detection of insertion of the document, the CPU 215
controls the CIS 101 to read the document image while
driving the document feed rollers 106 by a drive motor
(not shown).

        This document reading apparatus 100 has a function
10   of obtaining electric power from an external power
supply (preferably, a commercial power supply such as an
AC power supply or the like) 110 as a power supply other
than that of an external apparatus 400 such as a
computer or the like, and a function of obtaining
15   electric power from the external apparatus 400 via a
connection table (e.g., a USB cable) 300.

        Fig. 17 is a block diagram showing the circuit
arrangement of the image reading apparatus 100 shown in
Fig. 16.   The CIS 101 has an LED drive circuit 104a for
20   driving (controlling) the LED array 104 in addition to
the photodiode 102 and LED array 104 mentioned above.
When a document image is read, the LED drive circuit
104a turns on three, R, G, and B LEDs in turn upon
reading each line to illuminate a document in accordance
25   with a command from the CPU 215.   This illumination
light is reflected by the document and enters the
photodiode 102, which converts that light into an

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electrical signal. With this process, R, G, and B line-
sequential color read images are obtained.

An AMP (amplifier circuit) 204 amplifies the
signals output from the CIS 101, and supplies the
5   amplified signals to an A/D conversion circuit 205. The
A/D conversion circuit 205 converts the signals supplied
from the AMP 204 into digital data, and supplies the
digital data to a shading correction circuit 207.

A shading RAM 206 stores shading correction data
10   obtained by reading a calibration sheet in the same
manner as a document. The shading correction circuit
207 performs shading correction of the read image data
of the document on the basis of the data stored in the
shading RAM 206. A peak detection circuit 208 detects
15   peak values of the read image data in units of lines,
and is used to detect the leading end of the document.

A gamma conversion circuit 209 performs gamma
conversion of the read image data in accordance with a
gamma curve set by, e.g., the external apparatus 400
20   such as a computer or the like.

A buffer RAM 210 is a RAM (transmission buffer)
for temporarily storing image data to be sent to the
external apparatus 400. A packing/buffer RAM control
circuit 211 executes a process for executing a packing
25   process of the read image data in accordance with an
image output mode (e.g., binary, 4-bit multi-valued, 8-
bit multi-valued, 24-bit multi-valued, and the like) set

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in advance by the external apparatus 400 or the like, and writing the processed data in the buffer RAM 210, and a process for reading out the read image data written in the buffer RAM 210 and supplying the readout

5   data to an interface circuit 212.

The interface circuit 212 has a communication function of exchanging control information and image data with the external apparatus 400 such as a computer or the like via the connection table 300, and has a

10 function of receiving electric power supplied from the external apparatus 400. As for the types of interfaces, those compliant with USB 1.1, USB 2.0, and IEEE 1394, for instance, are preferable.

A power supply control circuit 221 supplies

15 electric power, which is supplied from the external apparatus 400 via the connection cable 300, to the internal units (components that require power supply) when the external power supply 110 cannot be used (e.g., when the external power supply 110 is not connected to a

20 plug 220), and supplies electric power to the respective units using the external power supply 110 when it can be used.

The CPU 215 has a ROM 215A that stores a control program, and a RAM 215B serving as a work area, and

25 controls the respective units in accordance with the control program stored in the ROM 215A. The CPU 215 can recognize the type of interface which is currently used

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by, e.g., referring to status of the interface circuit
212 supply control circuit 221.

A timing signal generation circuit 214 generates
various timing signals by frequency-dividing a periodic
signal output from a quartz oscillator 216 in accordance
with an instruction from the CPU 215. The CPU 215
selects an operation mode in accordance with the
interface which is currently used, and controls the
timing signal generation circuit 214 in accordance with
the operation mode.

Fig. 18 is a flow chart showing the operation of
the image reading apparatus according to the sixth
embodiment of the present invention shown in Figs. 16
and 17. Note that this operation is controlled by the
CPU 215 on the basis of the control program stored in
the ROM 215A. This control program may be externally
provided and installed in the image reading apparatus
100. That is, the control program itself also has the
industrial applicability. The control program can be
distributed while being stored in, e.g., a memory
medium, or via a network such as the Internet or the
like.

When the power supply is turned on, the CPU 215
refers to status of the interface circuit 212 in step
S101 to check if a high-speed communication mode (fast
mode) is used. If the high-speed communication mode is
used, the flow advances to step S102; if the high-speed

communication mode is not used (i.e., if low-speed
communication mode (slow mode) is used), the flow
advances to step S103.

        In step S102, the read mode is forcibly set in a
normal mode. In step S103, the read mode is forcibly
set in a power saving mode. In the power saving mode,
consumption power required in an image read operation or
the like is suppressed. In the power saving mode, for
example, the CPU 215 controls the respective units to
set a low operation speed of movable portions such as
the drive motor (not shown) for driving the feed rollers
106 and the like, and to reduce the amount of light
(drive power) of the LED array 104 that illuminates a
document. The normal mode is a mode other than the
power saving mode.

        Note that the power saving mode may suppress
consumption power in operations other than the image
read operation.

        In this way, when the low-speed communication mode
is selected, since the operation mode such as the read
mode or the like is set in the power saving mode,
electric power that the image reading apparatus 100
requires can be suppressed.

        <Seventh Embodiment>

        The image reading apparatus according to the sixth
embodiment of the present invention is a sheet-feed type
image reading apparatus, but the present invention can

also be applied to image reading apparatuses other than the sheet-feed type. An image reading apparatus other than the sheet-feed type will be exemplified below.

Fig. 19 shows a schematic arrangement of a flatbed-type image reading apparatus according to the seventh embodiment of the present invention. This image reading apparatus has a CIS 141, shaft 142, motor 143, platen 144, and pressure plate 146. In this image reading apparatus, a document 145 is placed on the platen 144, and its image is read while the CIS 141 is moved by the motor 143 in the direction of an arrow. Note that the arrangement of the control circuit can adopt that shown in Fig. 17. The operation of this embodiment is the same as that shown in Fig. 18.

<Eighth Embodiment>

Fig. 20 shows the circuit arrangement of a flatbed-type image reading apparatus according to the eighth embodiment of the present invention. Note that the same reference numerals in Fig. 20 denote the same building components as those of the image reading apparatus shown in Fig. 17.

A document reading apparatus 500 has a function of obtaining electric power from an external power supply (preferably, a commercial power supply such as an AC power supply or the like) 110, and a function of obtaining electric power from an external apparatus 400 such as a computer or the like via a connection table

(e.g., a USB cable) 300, as in the sixth and seventh
embodiments.

The image reading apparatus 500 of the eighth
embodiment has a control IC 501, in which an AMP 204,
A/D conversion circuit 205, shading correction circuit
207, peak detection circuit 208, gamma conversion
circuit 209, packing/buffer RAM control circuit 211,
interface circuit 212, timing signal generation circuit
214, control circuit 502, and control register 503 are
integrated.

The control IC 501 passes a command to the control
circuit 502 by turning on/off corresponding ones of a
plurality of control bits of the control register 503 in
accordance with a command supplied from the external
apparatus 400 via the connection cable 300. The control
circuit 502 executes a process in correspondence with
the states of the control bits of the control register
503. The external apparatus 400 can confirm the status
of the image reading apparatus 500 by reading out the
status bits of the control register 503 via the
connection cable 300 and interface circuit 212. The
control IC 501 has an input port 504 connected to the
power supply control circuit 221, and can confirm the
status of the power supply control circuit 221 on the
basis of a value input to the input port 504. More
specifically, the control IC 501 can recognize the
device connected to the interface circuit 212, assign

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addresses and decide the communication speed by performing enumeration when power is introduced. Information indicating the decided communication speed is also written in the status bits of the control

5 register 503 by the control circuit 502, and the external apparatus 400 can recognize the communication speed by reading out the status bits via the connection cable 300 and interface circuit 212.

Figs. 21 to 24 are flowcharts showing the

10 operation of the image reading apparatus shown in Fig. 20. Fig. 25 shows a schematic arrangement of the image reading apparatus 500 shown in Fig. 20.

When the connection cable 300 such as a USB cable or the like is connected to the connector of the

15 interface circuit 212, and the external apparatus 400 such as a computer or the like confirms it, the external apparatus 400 controls execution of processes shown in Fig. 21 in the image reading apparatus 500 (step S610).

In step S611, the external apparatus 400 confirms

20 if it can normally communicate with the image reading apparatus 500 and, after that, a default value is written in the control bits of the control register 503, thereby the image reading apparatus 500 is initialized. In step S612, the control IC 501 of the image reading

25 apparatus 500 conducts read/write tests of the buffer RAM 210 and shading RAM 206 in accordance with a command from the external apparatus 400.

In step S613, the control circuit 502 moves the CIS 141 to the home position, as shown in Fig. 25, in accordance with a command from the external apparatus 400. The home position is set outside the image read range, as shown in Fig. 25, and when a projection 148 provided to the CIS 141 intercepts a photointerrupter 147, it is detected that the CIS 141 is located at the home position. In step S614, the control circuit 502 moves the CIS 141 forward to fall outside the home position (to the right in Fig. 25) in accordance with a command from the external apparatus 400 so as to confirm if a home position sensor (not shown) works correctly. After that, the control circuit 502 moves the CIS 141 backward to the home position.

In this image reading apparatus 500, a reference plate 150 is set to contact the end portion of a platen glass 152. The reference plate 150 is formed by arranging white and black regions, each of which extends over the full main scan range, in the sub-scan direction. The boundary between the white and black regions corresponds to a document read reference position. The CIS 141 is located at a position corresponding to the black region when it is at its home position. In step S615, the control circuit 502 makes light adjustment of LEDs of the CIS 141 so as not to disturb the read operation of the CIS 141 of the document read reference position, moves the CIS 141

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forward, detects the document read reference position as
the number of steps of the motor 143, and stores it in
accordance with a command from the external apparatus
400. The control circuit 502 turns off the LESs of the
5 CIS 141, returns the CIS 141 to the home position, and
ends the detection process of the document read
reference position.

After the processes shown in Fig. 21, a
calibration process shown in Fig. 22 is executed in
10 accordance with a calibration instruction from the
external apparatus 400 (step S621). In step S622, the
control circuit 502 reads the output from the CIS 141
for a plurality of lines while the CIS 141 is located at
the home position (a position corresponding to the black
15 region) and the LEDs of the CIS 141 are kept OFF, in
accordance with a command from the external apparatus
400. The average value of the read outputs is then
stored as black calibration data in the shading RAM 206.

In step S624, the control circuit 502 performs
20 enumeration to decide the communication speed of the
interface circuit 212. As a result, if the
communication speed is that of a fast mode, then the
flow advanced to step S625, whereas, if the
communication speed is not that of a fast mode (i.e., a
25 slow mode), the flow advances to step S626.

In step S625, the control circuit 502 turns on the
LEDs of the CIS 141 with "light amount 2" for the normal

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mode, moves the CIS 141 to the white region of the reference plate 150, and reads the output from the CIS 141 for a plurality of lines. The control circuit 502 generates "white calibration data 2" on the basis of
5 high-output data of the read data for the plurality of lines, and stores it in the shading RAM 206.

In step S626, the control circuit 502 turns on the LEDs of the CIS 141 with "light amount 1" for the power saving mode, generates "white calibration data 1" by the
10 same method upon generating "white calibration data 2", and stores it in the shading RAM 206.

After generation of "white calibration data 1" or "white calibration data 2", the image reading apparatus 500 shifts to a standby state (step S627). In the
15 standby state, the external apparatus 400 monitors the status bits of the control register 503 constantly or periodically. The calibration data is used in shading correction.

In the standby state, when the status shifts from
20 the slow mode to the fast mode, the process shown in Fig. 23 is executed (step S631). The status shift from the fast mode to the slow mode is detected by, e.g., monitoring the kinds of devices connected to the interface circuit 212. In step S632, the control
25 circuit 502 turns on the LEDs of the CIS 141 with "light amount 2" for the normal mode, moves the CIS 141 to the white region of the reference plate 150, and reads the

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output from the CIS 141 for a plurality of lines as in
step S625. The control circuit 502 generates "white
calibration data 2" on the basis of high-output data of
the read data for the plurality of lines, and stores it

5   in the shading RAM 206. In this manner, "white
calibration data 2" required for reading an image in the
normal mode is prepared. After that, the image reading
apparatus shifts to the standby state again.

Upon receiving a read instruction from the

10 external apparatus 400 in the standby state, the process
shown in Fig. 24 is executed (step S641). In step S642,
the control circuit 502 decides the communication speed
by obtaining information relating communication mode of
a communication channel. If the communication speed is

15 that of the fast mode, the flow advances to step S647;
if the communication speed is not that of the fast mode
(i.e., that of the slow mode), the flow advances to step
S644. Advancing to step S644 means that an image is
read in the power saving mode, and advancing to step

20 S647 means that an image is read in the normal mode.

In the power saving mode, the control circuit 502
turns on the LEDs of the CIS 141 with "light amount 1"
for the power saving mode in step S644, moves the CIS
141 to a document read start reference position in step

25 S645, and starts document read at "read speed 1" for the
power saving mode in step S646. In this case, the
shading correction circuit 207 executes shading

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correction of A/D-converted read image data using "black
calibration data" and "white calibration data 1" stored
in the shading RAM 206.

On the other hand, in the normal mode, the control
circuit 502 turns on the LEDs of the CIS 141 with "light
amount 2" for the normal mode in step S647, moves the
CIS 141 to a document read start reference position in
step S648, and starts document read at "read speed 2"
for the normal mode in step S649. In this case, the
shading correction circuit 207 executes shading
correction of A/D-converted read image data using "black
calibration data" and "white calibration data 2" stored
in the shading RAM 206. Note that (light amount 1) <
(light amount 2), and (read speed 1) < (read speed 2).

Upon receiving a read cancel instruction from the
external apparatus 400 or the like during the document
read operation, the control circuit 502 cancels read in
step S650. If no cancel instruction is input, the
document is read to its last line (YES in step S651).

Upon completion of read, the control circuit 502
turns off the LEDs of the CIS 141 in step S652, returns
the CIS 141 to the home position in step S653, and stops
the motor 143 for driving the CIS 141 in step S654. The
read image data undergoes a process designated by the
external apparatus 400, and is temporarily saved in the
buffer RAM 210. The control circuit 502 transfers the
image data temporarily saved in the buffer RAM 210 to

the external apparatus 400 via the connection cable 300
in step S655.

The present invention can also be applied to an
image reading apparatus in which a document and
photoelectric conversion elements are fixed in position,
and an illumination device and mirror are scanned. When
such an image reading apparatus is used, electric power
for driving a scanning unit (e.g., illumination device,
mirror, and the like) for optically scanning a document
is set to be relatively small to lower a scanning speed
in the slow mode; in the fast mode, electric power for
driving the scanning unit is set to be relatively large
to higher the scanning speed.

According to the eighth embodiment as described
above, energy consumption is properly controlled in
accordance with an interface which is used.

It should be noted that the present invention
includes combinations of the aforesaid embodiments or
technical elements disclosed therein.

<Other Embodiment>

The present invention can be applied to a system
constituted by a plurality of devices (e.g., host
computer, interface, scanner, video camera) or to an
apparatus comprising a single device (e.g., copying
machine, facsimile machine).

Further, the object of the present invention can
also be achieved by providing a storage medium storing

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program codes for performing the aforesaid processes to
a computer system or apparatus (e.g., a personal
computer), reading the program codes, by a CPU or MPU of
the computer system or apparatus, from the storage
5   medium, then executing the program.

In this case, the program codes read from the
storage medium realize the functions according to the
embodiments, and the storage medium storing the program
codes constitutes the invention.

10   Further, the storage medium, such as a floppy disk,
a hard disk, an optical disk, a magneto-optical disk,
CD-ROM, CD-R, a magnetic tape, a non-volatile type
memory card, and ROM can be used for providing the
program codes.

15   Furthermore, besides aforesaid functions according
to the above embodiments are realized by executing the
program codes which are read by a computer, the present
invention includes a case where an OS (operating system)
or the like working on the computer performs a part or
20   entire processes in accordance with designations of the
program codes and realizes functions according to the
above embodiments.

Furthermore, the present invention also includes a
case where, after the program codes read from the
25   storage medium are written in a function expansion card
which is inserted into the computer or in a memory
provided in a function expansion unit which is connected

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to the computer, CPU or the like contained in the
function expansion card or unit performs a part or
entire process in accordance with designations of the
program codes and realizes functions of the above
5   embodiments.

   In a case where the present invention is applied to
the aforesaid storage medium, the storage medium stores
program codes corresponding to the flowcharts described
in Figs. 7 and 8, or Figs. 10 and 11, or Figs. 14 and
10 15, or Fig. 18, or Figs. 21 to 24, or combinations
thereof.

   The present invention is not limited to the above
embodiments and various changes and modifications can be
made within the spirit and scope of the present
15 invention.   Therefore to apprise the public of the scope
of the present invention, the following claims are made.